



## SPECIFICATION

### CONVECTION/IMPINGEMENT OVEN FOR CONTINUOUSLY COOKING FOOD

#### BACKGROUND OF THE DISCLOSURE

The field of the invention is cooking ovens and the invention relates more particularly to ovens of the type used to commercially bake, broil or otherwise cook meats, baked goods and other foods. With the increased use of frozen dinners, the moisture content in the meat contained in a frozen dinner has become more critical. Since microwave cooking tends to heat water, it is important that sufficient water be retained in the meat so that after it is microwaved it has the desired flavor and texture.

Many patents have been granted on continuous cooking ovens. For instance the Straub patent no. 3,604,336 shows a moving belt with upper and lower burners, a center exhaust duct is provided and no provision is made for moisture control of the finished product.

The Szabrak et al patent no. 3,721,178 also uses many burners along the length of the oven. The Nerthling patent no. 3,823,660 utilizes a continuous moving belt with radiant heaters above and below the food to be cooked. Burners are also used and the exhaust vent is positioned along one side of the entire length of the oven.

The Fagerstrom et al patent shows an electrical heating device over which air is passed after which it passes through channels above and below the product to be cooked. The cooking vapors are vented at points along the oven. The Caridis et al patent no. 3,947,241 shows a recirculating oven wherein a flame is fed into an upper chamber and

1 then passes in a u-shaped path into the lower chamber where the product to be cooked is  
2 located. A certain amount of cooking vapors is exhausted at both ends of the oven.

3 A charmaker is shown in the Fetzer patent no. 4,026,201 which uses many rings  
4 which are heated and ride on the upper surface of the food product. The Baker et al  
5 patent no. 4,121,509 utilizes electric heating elements and recirculated air which passes  
6 through tubes at the end of the oven and flows against the upper and lower surface of the  
7 food to be cooked.

8 The Caridis et al patent no. 4,167,585 is similar in structure to patent no.  
9 3,947,241 and is basically a recirculation system wherein water vapor is injected into the  
10 moving stream of process vapor to control the temperature and moisture content.

11 The Benson et al patent no. 4,297,942 shows a branding process utilizing an  
12 oversized screen with upper and lower burners, the heat from which it is exhausted from  
13 the branding unit. The Baker patent no. 4,936,286 is a small continuous broiler which  
14 has three side-by-side conveyors. The Leary et al patent no. 4,949,629 is a continuous  
15 cooking oven which has two very separate cooking zones, both zones utilize recirculation  
16 of the cooking vapors. Lastly, the Barkhau et al patent no. 4,991,497 cooks food in a  
17 closed bottom tray and utilizes air high velocity impingement nozzles to accomplish the  
18 cooking. The air is recirculated.

19 Although one would think that recirculation of cooking vapor would result in an  
20 efficient unit, this is not the case. Since ovens must be constructed in a manner so that  
21 they can be easily and completely cleaned, it is not practical to place an outer layer of  
22 insulation on the oven. Therefore, the large additional surface area that is required to  
23 bring about recirculation radiates more than the amount of heat saved in recirculation.  
24 Furthermore, for some products such as pork, the recirculation process results in an  
25 undesirable pink color in the meat even though it is completely cooked. Therefore, an

1 oven which is more efficient in the use of heat would be highly desirable. Still further, it  
2 is useful to be able to cook various different types of food products requiring a wide  
3 range of controls for heat temperature and humidity.

4

## 5 SUMMARY OF THE INVENTION

6 The present invention is for an improved convection/impingement oven for  
7 continuously cooking food. The oven is of the type having a pervious, continuous,  
8 moving belt which has an upper product supporting surface referred to as a "food  
9 supporting belt" and a return belt portion. The food supporting belt has a lower surface  
10 which permits the passage of hot air or other vapors upwardly therethrough and the  
11 passage of fat or other drippings downwardly therethrough. The food passes from a  
12 product feed end to a product discharge end through a closed elongated cooking chamber  
13 which is enclosed by a top, two sides, and a bottom. The food supporting belt and the  
14 return belt both pass through this chamber. A burner blower is supplied with outside air  
15 and feeds air to at least one burner which feeds hot air to a first manifold which is at  
16 about atmospheric pressure and has an air intake which permits atmospheric air to enter  
17 from outside the oven. A second blower then takes the atmospheric pressure hot air and  
18 increases the pressure thereof for later feeding into a low pressure, hot-air manifold and  
19 from there through air impingement nozzles onto the food to be cooked. A plurality of  
20 upper air impingement nozzles are positioned above the food supporting belt and these  
21 nozzles are fed from an upper air impingement manifold which in turn is supplied from  
22 the said low pressure hot air manifold. A plurality of lower air impingement nozzles are  
23 positioned below the lower surface of the food supporting belt, and this is fed from a  
24 lower air impingement manifold which in turn is fed by the low pressure hot air  
25 manifold. Means are provided for independently controlling the flow of hot air to the

1 upper air impingement manifold and to the lower air impingement manifold. A cooking  
2 vapor vent having an inlet positioned adjacent the product discharge of the cooking  
3 chamber comprises the only outlet for the cooking vapors. The cooking vapors move  
4 along the cooking chamber and hot air is introduced along the length of the chamber  
5 thereby causing the hot air flow, concurrently with the food-supporting surface, to move  
6 at an ever increasing rate along the cooking oven. Preferably the lower hot air  
7 impingement units and the upper hot air impingement units are fed by separate burners  
8 and blowers. Also preferably a color development and sealing unit is positioned at the  
9 product feed end of the cooking chamber and upper and lower burners are played upon  
10 the food to be cooked (and preferably a branding wheel) and the heat from these two  
11 burners is passed the entire length of the cooking chamber. The color development and  
12 sealing burners are adjustable so that the direction of the flame may made from horizontal  
13 to directly downwardly. It is also preferable that a plurality of steam nozzle assemblies  
14 are positioned along the cooking chamber, preferably between the impingement units.  
15 Also, preferably the steam nozzles are separated into several discreet groups which are  
16 independently controllable so that different zones of the oven can be of different humidity  
17 and/or temperature.

18 The present invention is also for a process of cooking food comprising the steps of  
19 placing an object to be cooked on the upper surface of a perforate moving belt. Next, a  
20 color development and sealing flame is aimed so that the heat therefrom passes into the  
21 entrance of an elongated cooking chamber. Steam may next be introduced above and  
22 below the object to be cooked and hot air is impinged on the upper and lower surface  
23 with the temperature and force of the impinging stream of hot air from the upper nozzles  
24 being independently controlled from that from the lower nozzles. The object to be  
25 cooked is passed through at least one set of upper and lower air impingement nozzles and

1 upper and lower steam nozzles and the finally cooked product is removed at the product  
2 discharge end.

### 3 BRIEF DESCRIPTION OF THE DRAWINGS

4 Figure 1 is a plan view of the improved convection/impingement cooking oven of  
5 the present invention.

6 ~~Fig. 1A is an enlarged plan view of the impingement console unit of Fig. 1.~~

7 Figure 2 is a cross sectional view taken along line 2-2 of Fig. 1.

8 Fig. 3 is an enlarged cross sectional view of the product feed end of the oven of  
9 Fig. 1 including the color development and sealing assembly, a steam nozzle assembly,  
10 and a hot air impingement assembly.

11 Fig 3A is an enlarged view taken along line 3A ~~X~~<sup>of</sup> Fig. 3.

12 Fig. 4 is a cross sectional view taken along line 4-4 of Fig. 3.

13 Fig. 5 is an enlarged cross sectional view of the product discharge end of the oven  
14 of Fig. 1.

15 Fig. 6 is a cross sectional end view showing the oven of Fig. 1 with the hood  
16 thereof raised.

17 Fig. 7 is a front view of the control panel of the cooking unit of Fig. 1.

18 Fig. 8 is a diagrammatic view of the control panel of Fig. 7.

### 19 20 DESCRIPTION OF THE PREFERRED EMBODIMENTS

21 *Start C1* The improved convection/impingement oven of the present invention is shown in  
22 Figs. 1 and 2 and indicated by reference character 10. Oven 10 has a product feed end  
23 11 and a product discharge end 12. The food to be cooked is placed on a pervious,  
24 continuous, moving belt 13 which is fabricated from a plurality of linked rods, of steel or  
25 other construction known in the art. The unit is operated from a control counsel 14, and

1 an impingement console 15 contains the burners for feeding the air impingement unit.  
2 Details of the impingement console are shown in Fig. 1A.

3 A cross sectional view of oven 10 is shown in Fig. 2 where it can be seen that the  
4 upper part of belt 13 moves from left to right as shown in Fig. 2 and passes through an  
5 elongated cooking chamber which is shown more clearly in Figs. 3 and 4, where it is  
6 indicated by reference character 16. As the food to be cooked passes along the forward  
7 moving portion 17 of the belt 13, (the forward moving portion 17 is called the "food  
8 supporting belt") upper and lower air impingement nozzles such as those indicated in Fig.  
9 2 by reference characters 18 and 19 pass hot air onto the upper and lower surface of the  
10 product to be cooked. Also, steam nozzles assemblies such as indicated in Fig. 2 by  
11 reference characters 62, 70, and 73 pass steam or water vapor into the cooking vapor 21  
12 which forms above and below the food to be cooked.

13 The essential feature of the present invention is the ability to separately control  
14 both the temperature and volume emitted from the upper and lower air impingement  
15 nozzles in the oven. As shown in Fig. 1A, a blower assembly 22 feeds air 23 and fuel  
16 28 to a burner nozzle 25. Burner nozzle 25 forms a flame which heats the air in the  
17 interior of manifold 27. The interior of manifold 27 is at about atmospheric pressure and  
18 draws air 24 as needed through conduit 24 which is open to the exterior of the oven.  
19 Conduit 24 does not draw any recirculated hot air from vent 83. Similarly, a blower  
20 assembly 182 feeds air 123 and fuel 123 to a burner nozzle 125. Burner nozzle 125  
21 forms a flame which heats the air in manifold 127. The hot air in manifold 127 is at  
22 about atmospheric pressure and draws air 124 as needed through conduit 124 which also  
23 is drawn from outside the oven. The hot air at atmospheric pressure in manifold 27 is  
24 fed to a blower assembly 29 which increases its pressure to from one-half to ten psig.  
25 As blower assembly 29 requires more hot air, above that required to simply move the

1 gasses exiting nozzle 25, it is supplied by the air stream ~~24~~ entering conduit 24 so it  
2 never has a negative feed pressure. Blower assembly 29 feeds the hot air into a hot air  
3 conduit 31 from which it passes into the upper hot air manifold 32 shown in Figs. 3, 5,  
4 and 6. Blower assembly ~~29~~<sup>30</sup> feeds hot air from manifold ~~32~~<sup>28</sup> to lower hot air conduit 33  
5 (which is directly below conduit 31 in Fig. ~~1A~~<sup>9</sup>) from which it passes into lower hot air  
6 manifold 34. Both the burner assembly 22/23/~~28~~<sup>30</sup>/25 and 122/123/123'/125 and the  
7 blower assemblies 29 and ~~129~~<sup>30</sup> may be independently controlled so that the temperature as  
8 well as the air pressure may be set to a preferred level for the product to be cooked.

9 Turning now to Figs. 3 and 6, the lower hot air manifold 34 feeds hot air into  
10 right and left hot air channels 38 and 39 which feed a lower air impingement nozzle  
11 assembly 19. Air under a relatively low pressure (one-half to ten pounds per square inch  
12 gauge) passes outwardly through upwardly directed holes 85 (see Fig. 3A) in the plates of  
13 the nozzle and impinges upon the food to be cooked. Hot air also passes outwardly  
14 through holes 88 in an angled plate 87 which directs hot air both downwardly and toward  
15 vent 83 down the oven chamber. Similarly, holes in nozzle assembly 18, fed by channels  
16 35 and 36, urge hot air downwardly and forwardly to impinge the food and to help urge  
17 the gas flow down the oven chamber to the vent 83. This not only heats the food by  
18 conduction but also tends to remove any stagnant air and vapor layer which surrounds the  
19 food. Thus, the food is heated more efficiently and more quickly by the fact of the air  
20 impingement. It further carries with it the surrounding cooking vapor with its  
21 temperature and humidity so that the food is more quickly raised to the desired  
22 temperature. Since the food supporting belt 17 is largely open, the hot air passes readily  
23 through it and around all sides of the food to be cooked (which is indicated by reference  
24 character 41 in Fig. 6).

25 The surfaces of the cooking chamber are shown in Fig. 6 although the hood 42

1 has been raised therefrom. The upper wall of the cooking chambers indicated by  
2 reference character 43 and the left side wall by 44 and the right side wall by 45. The  
3 base portions 46 and 51 rest in the sealing lips 47 and 52 of the lower pan 61 when the  
4 hood is lowered. The hood consisting of walls 43, 44 and 45 are held on a cross  
5 member 53 which is, in turn, held by two vertical members 54 and 55. Members 54 and  
6 55 are supported by rods 56 and 57. The hood is raised and lowered by a chain hoist 40  
7 supported by frame 50. Rods 56 and 57 telescope into vertical members 54 and 55 so  
8 that as hood 42 is lowered, the base 58 thereof rests upon the frame to create a dead air  
9 space 60 above the upper surface and the side walls of the cooking chamber. The lower  
10 pan of the cooking chamber is indicated by reference character 61 which provides a  
11 conventional slanted grease or other liquid removing floor. It is important that the air  
12 volume of the cooking chamber be relatively small so that only the air necessary for  
13 cooking need be heated and the outer surface of the cooking chamber be minimized to  
14 minimize radiation heat loss. Outer sides are, of course, provided along the entire length  
15 of the oven to further reduce heat loss.

16 Returning now to Figs. 3 and 4, a steam nozzle assembly 62 is shown in side  
17 view in Fig. 3 and in front view of Fig. 4. A steam line 63 is controlled by a steam  
18 valve 64 shown in Fig. 2. This is independently controlled from steam valves 65 and 66  
19 which provides the operator with additional temperature and moisture control. It is, of  
20 course, understood that the term "steam" is intended to include a spray of water mist  
21 which is quickly turned to steam in the high temperatures of the cooking chamber.  
22 Returning to Fig. 3 steam nozzle assembly 62 emits an upper stream of steam 67 and a  
23 lower stream of steam 68 through nozzles 20. Since the product to be cooked has just  
24 passed through a high temperature color development and sealing operation, the streams  
25 of steam 67 and 68 tend to extinguish any flareup that may occur. Also, it should be

1       noted that the streams 67 and 68 are directed toward the discharge end 12 of the oven  
2       which helps move the cooking vapor 21 concurrently with respect to the food supporting  
3       belt 17. A separate steam line 69 supplies a steam nozzle assembly 70 which also has a  
4       pair of streams of steam 71 and 72. Steam nozzle assembly 70 is controlled by steam  
5       valve 65 as are the other steam nozzle assemblies indicated by reference character 70 in  
6       Fig. 2. Steam nozzle assemblies 73 shown in Fig. 2 are controlled by steam valve 66.

7       Turning now to the color development and sealing assembly, an upper color  
8       development and sealing burner 74 (see Fig. 3) is fed with high pressure air and gas to  
9       provide a flame 75 which heats the upper surface of food 41 to be cooked. This provides  
10      coloring and sealing to the food. Similarly, a lower color development and sealing  
11      burner 76 has a flame 77 which heats the lower surface of food product 41. The heat  
12      from both the upper and lower flames 75 and 77 heat a branding wheel 78 which is  
13      driven by a chain link belt 79 from a gear 80 which also contacts the continuous moving  
14      belt 13. Branding wheel 78 is floating so that it will rise if necessary. Branding wheel  
15      78 may also be permanently raised to eliminate any branding. The branding rods 81  
16      always move at the same speed as a food supporting belt 17 to provide a neat brand on  
17      the upper surface of food product 41. The lower side of the food product 41 is branded  
18      by the moving belt 13, although belt 13 may be cooled to eliminate branding if desired.

19       Burners 74 and 76 may be aimed through a 90 degree arc. They may be aimed  
20      horizontally toward the cooking chamber or at any angle between horizontally to directly  
21      downwardly and upwardly respectively toward the moving belt 17. The choice of  
22      direction depends on the amount of coloring and sealing desired and the type of food  
23      being cooked. Thus the flames 75 and/or 77 may be aimed to directly impinge the  
24      surfaces of the food to be cooked, or they may merely heat the surfaces depending on  
25      how the burners 74 and 76 are aimed.

An important feature of the color development and sealing assembly is the aiming of the flames 75 and 77 toward the opening of the cooking chamber and the conveying of the heat from these flames into the cooking chamber. The portion of the cooking chamber which surrounds the branding rods is in a stair stepped shape indicated by reference character 82. The hot air is moved inwardly into the cooking chamber and not exhausted in a separate vent. The hot air carries the entire length of the cooking chamber and is not vented until it passes out of the cooking vapor vent 83 shown in Figs. 1 and 2. Also the upper color development and sealing burner and the lower color development and sealing burner are independently controlled so that the proper amount of heat may be applied depending on the product being cooked.

The construction of the upper and lower impingement manifolds is a very important feature of the present invention. Fig. 3a shows the top of lower and upper air impingement manifolds 19 and 18 where it can be seen that nozzle 19 has a nozzle plate 84 with a plurality of small holes 85 which causes the air to move out in small discrete streams against the product to be cooked. There are no nozzles on the angled face 86 but there are nozzles on the angled face 87 which are indicated by reference character 88. Similarly upper air impingement manifold 18 has a nozzle plate 89 shown in Fig. 3 in side view which also has a plurality of holes 90. An angled face 91 also has a plurality of holes 92 but angled face 93 has no holes. This causes the air to be urged downwardly and also at an approximately 45 degree angle in the direction of the discharge and to help move the cooking vapors 21 along the oven. It is also evident in Fig. 3 that the upper surface 43 of cooking chamber 16 is angled upwardly as indicated by reference character 94 to accommodate the air impingement manifolds as well as the steam manifolds. This causes the internal volume of the cooking chamber to be minimized and helps to increase the velocity of the cooking vapor 21 concurrently with the food supporting belts 17.

1       Also viewing Fig. 2 it is evident to see that with the multiple entries of hot air  
2       and steam the volume of cooking vapors increases along the chamber so that as the food  
3       becomes more cooked, the cooking vapor 21 increases in velocity.

4       Further details of construction of the steam nozzle assembly is shown in Fig. 4  
5       where it can be seen that steam line 63 feeds a vertical steam line 95. This, in turn,  
6       feeds an upper horizontal steam manifold 96 and a lower horizontal steam manifold 97.  
7       Each of these manifolds have a plurality of individual nozzles 20 which urge the streams  
8       of steam in the direction shown for instance, in Fig. 3 indicated by reference character 67  
9       and 68.

10      Another important feature of the present invention is the single pass operation  
11      where the only significant venting of cooking vapor is through cooking vapor vent 83  
12      which includes a damper 99 and an air blower, not shown, positioned upwardly from  
13      damper 99. Air is thus drawn upwardly through vent 83 and is exhausted and is not  
14      recirculated.

15      As the food 41 passes along the cooking chamber, it tends to draw heat out of the  
16      cooking vapors 21. Thus, although the temperature may be as high as 1000 to 1600  
17      degrees Fahrenheit near the product feed end of the cooking chamber, it decreases along  
18      the chamber. For example, it may drop to 800, 600, 400 and 300 degrees in some  
19      instances, along the chamber so that as the food warms, the cooking temperature  
20      difference between the product and the cooking vapors 21 decreases. This characteristic  
21      optimizes the cooking operation and reduces the possibility of overcooking in a manner  
22      not possible in the typical oven or a recirculating oven which remains at a relatively  
23      constant temperature.

24      Also shown in Fig. 5 is a belt cleaning loop 100 which causes the belt to pass  
25      through a tank 101 filled with water 102. It has been found that the belt remains

1        relatively clean during most cooking operations. If it is desired to add non-stick coatings  
2        to the belt, they can be added to tank 102.

3        Control panel 103 is shown in Figs. 7 and 8. The cooking unit is provided with  
4        numerous means for controlling temperature, air flow, humidity, and belt speed.  
5        Appropriate monitoring units such as pressure sensing means, thermocouples and other  
6        sensors provide input to the control panel for facilitating the operation of the unit. The  
7        controls are more specifically set forth in Fig. 8. Particular note is made of the wide  
8        variety of controls available on both the upper impingement unit and the lower  
9        impingement unit. The result is a highly versatile and yet efficient continuous  
10      convection/impingement cooking oven which is capable of placing the optimum  
11      temperature, time and humidity together with upper and lower air flow impingement on  
12      the food to be cooked so that the best possible product will result.

13      The present embodiments of this invention are thus to be considered in all respects  
14      as illustrative and not restrictive; the scope of the invention being indicated by the  
15      appended claims rather than by the foregoing description. All changes which come  
16      within the meaning and range of equivalency of the claims are intended to be embraced  
17      therein.